



THE AMERICAN ASSOCIATION FOR
LABORATORY ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

U.S. ARMY PRIMARY STANDARDS LABORATORY Redstone Arsenal, AL

for technical competence in the field of **Calibration**

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of any additional program requirements in the field of calibration. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 18 June 2005*).

Presented this 23rd day of January 2007.

A handwritten signature in black ink, appearing to read "Peter Ringe".

President
For the Accreditation Council
Certificate Number 1256.01
Valid to December 31, 2008



For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

U.S. ARMY PRIMARY STANDARDS LABORATORY
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CALIBRATION

Valid To: December 31, 2008

Certificate Number: 1256.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Electrical – DC/Low Frequency

Parameter	Range	Best Uncertainty ² (\pm)	Comments
DC Voltage –	(0 to 220) mV (220 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1000) V	9 μ V/V + 0.5 μ V 6 μ V/V + 0.8 μ V 4 μ V/V + 3 μ V 4 μ V/V + 5 μ V 6 μ V/V + 50 μ V 8 μ V/V + 500 μ V	Fluke 5720
Fixed Points	1 V 10 V	0.1 parts in 10^6 0.04 parts in 10^6	Josephson Array system
DC Resistance –	(1 to 10) m Ω (10 to 100) m Ω 100 m Ω to 1 Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω	4.7 parts in 10^6 4.5 parts in 10^6 0.71 parts in 10^6 0.22 parts in 10^6 0.64 parts in 10^6 0.83 parts in 10^6 0.46 parts in 10^6 2.7 parts in 10^6 3.9 parts in 10^6	Direct comparison with current comparator using an MI 6010B and 6000A
Fixed Points	10 M Ω 100 M Ω 1 G Ω 10 G Ω 100 G Ω 1 T Ω	0.028 % 0.029 % 0.058 % 0.073 % 0.079 % 0.069 %	Penn Airborne resistors with Guildline 6500

Parameter	Range	Best Uncertainty ² (\pm)	Comments	
Inductance – Fixed Points	0.1 mH (1, 10, 100) mH 1 H 10 H	0.13 % 0.055 % 0.075 % 0.027 %	Comparison with reference standards using General Radio RLC Digibrige	
Capacitance – Fixed Points	10 pF 100 pF 1000 pF	3.0 parts in 10^6 2.9 parts in 10^6 3.0 parts in 10^6	Comparison to reference standards using Andeen-Hagerling 2500A	
AC Ratio	400 Hz and 1 kHz	1.1 parts in 10^6	Ratio techniques	
Risetime	> 15 ps Tr	9 ps	Comparison w/standard pulse generators using digital sampling system	
VOR Bearing Angle	0° to 330°	0.01°	Comparison with NIST VOR standard using NIST automated system	
AC/DC Difference – Current Shunts	(10 to 250) mA 500 mA 1 A 2.5 A 5 A 10 A 20 A	10 kHz 10 kHz 10 kHz 10 kHz 10 kHz 10 kHz 10 kHz	50 parts in 10^6 44 parts in 10^6 46 parts in 10^6 54 parts in 10^6 58 parts in 10^6 68 parts in 10^6 84 parts in 10^6	Current shunt technique ESL-17: direct comparison with NIST calibrated current shunt standards

Parameter	Range	Best Uncertainty ² (\pm)	Comments
AC/DC Difference –			
Voltage			
0.5 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	24 parts in 10^6 14 parts in 10^6 12 parts in 10^6 14 parts in 10^6 21 parts in 10^6 34 parts in 10^6 47 parts in 10^6 0.011 %	AC voltage measurement technique ESL-7: intercomparison with NIST TVC using a Fluke 5720, 5725 and 5215
1 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	19 parts in 10^6 12 parts in 10^6 11 parts in 10^6 11 parts in 10^6 19 parts in 10^6 30 parts in 10^6 59 parts in 10^6 82 parts in 10^6	
2 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	15 parts in 10^6 13 parts in 10^6 9 parts in 10^6 14 parts in 10^6 11 parts in 10^6 12 parts in 10^6 21 parts in 10^6 32 parts in 10^6	
3 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	15 parts in 10^6 14 parts in 10^6 15 parts in 10^6 14 parts in 10^6 12 parts in 10^6 18 parts in 10^6 34 parts in 10^6 77 parts in 10^6	
6 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	16 parts in 10^6 13 parts in 10^6 11 parts in 10^6 12 parts in 10^6 14 parts in 10^6 20 parts in 10^6 26 parts in 10^6 0.03 %	

Parameter	Range	Best Uncertainty ² (\pm)	Comments
AC/DC Difference –			
Voltage (cont)			
10 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	16 parts in 10^6 14 parts in 10^6 13 parts in 10^6 9 parts in 10^6 11 parts in 10^6 12 parts in 10^6 66 parts in 10^6 0.043 %	AC voltage measurement technique ESL-7: intercomparison with NIST TVC using a Fluke 5720, 5725 and 5215
20 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	25 parts in 10^6 19 parts in 10^6 13 parts in 10^6 12 parts in 10^6 11 parts in 10^6 19 parts in 10^6 0.014 % 0.023 %	
30 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	17 parts in 10^6 13 parts in 10^6 11 parts in 10^6 9 parts in 10^6 16 parts in 10^6 28 parts in 10^6	
60 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	23 parts in 10^6 16 parts in 10^6 14 parts in 10^6 20 parts in 10^6 13 parts in 10^6 18 parts in 10^6	
100 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	20 parts in 10^6 14 parts in 10^6 12 parts in 10^6 12 parts in 10^6 16 parts in 10^6 70 parts in 10^6	
200 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.011 % 25 parts in 10^6 23 parts in 10^6 13 parts in 10^6 16 parts in 10^6 25 parts in 10^6	

Parameter	Range	Best Uncertainty ² (\pm)	Comments
AC/DC Difference – Voltage (cont)			
300 V	(20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	22 parts in 10^6 24 parts in 10^6 18 parts in 10^6 26 parts in 10^6 51 parts in 10^6	AC voltage measurement technique ESL-7: intercomparison with NIST TVC using a Fluke 5720, 5725 and 5215
600 V	(20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	23 parts in 10^6 28 parts in 10^6 22 parts in 10^6 30 parts in 10^6 37 parts in 10^6	
950 V	50 Hz (50 to 400) Hz 400 Hz to 20 kHz	31 parts in 10^6 31 parts in 10^6 58 parts in 10^6	
AC/DC Difference – Voltage			
(0.45 to 30) V	1 MHz 3 MHz 10 MHz 30 MHz 100 MHz	0.023 % 0.024 % 0.052 % 0.14 % 1.4 %	AC voltage measurement technique ESL-29: inter- comparison with NIST TVC using a Fluke 5720 and 6060B

II. Time and Frequency

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Frequency	0.1 MHz, 1 MHz, 5 MHz, 10 MHz	1 part in 10^{12}	Direct comparison w/master oscillator using NIST-developed frequency measurement technique
Frequency Counters – Band and Frequency (as required)	To 110 GHz	1 part in 10^9	Comparison with master oscillators

III. Electrical – RF/Microwave

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
RF Power – Measure			Power ratio with standard thermistor mounts
Calibration Factors (0.1 to 10) mW			
Coaxial Type N	50 MHz 0.1 MHz to 1.0 GHz (1 to 10) GHz (10 to 18) GHz	0.42 % 1.0 % 1.0 % 1.2 %	Weinschel M1111 Weinschel M1111 and Tegam 1120
Coaxial 3.5 mm	50 MHz to 18 GHz (18 to 26.5) GHz	1.8 % 2.8 %	Agilent 8485A with adapter
Coaxial 2.92 mm	50 MHz to 18 GHz (18 to 26.5) GHz (26.5 to 40) GHz	1.8 % 2.8 % 3.5 %	Agilent 8487A with adapter
Coaxial 2.4 mm	(0.05 to 10) GHz (10 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	1.8 % 2.0 % 3.0 % 5.0 %	Agilent 8474E
RF Power – Measure			Power ratio with standard thermistor mounts
Waveguide Calibration Factors (0.1 to 10) mW			
X band (WR-90)	(8.2 to 12.4) GHz	1.5 %	Agilent X486A
Ku band (WR-62)	(12.4 to 18) GHz	1.8 %	Agilent P486A
K band (WR-42)	(18 to 26.5) GHz	1.5 %	Agilent K486A
Ka band (WR-28)	(26.5 to 28) GHz (28 to 37) GHz (37 to 40) GHz	2.5 % 1.5 % 2.0 %	Agilent R486A
Q band (WR-22)	(43 to 45) GHz	2.8 %	Hughes Microwave 45772H-1100

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Peak Power – Measure			Power ratio with standard thermistor mounts
Coaxial Type N (0.1 to 10) mW	(0.5 to 18) GHz	0.2 dB	Agilent 8478B and Weinschel 6759B-10 synthesizer
RF Wattmeters – Measure, (1 to 180) W			Power ratio with standard thermistor mounts using an automated Brammall cascaded ratio technique, Agilent 478AH-72
Coaxial Type N Coaxial 14 mm	(0.4 to 1000) MHz (0.4 to 1000) MHz	2.0 % 2.0 %	
Thermal Noise – Measure, (5 to 40) dB ENR			Ratio technique with standard noise sources
Coaxial Type N	(0.03 to 10) GHz (10 to 18) GHz	0.3 dB 0.4 dB	Agilent 346B
Coaxial 3.5 mm	(0.03 to 18) GHz (18 to 26.5) GHz	0.5 dB 0.6 dB	Agilent 346C
Electromagnetic Field Strength – Measure (20 to 62) V/m	0.1 MHz to 45 GHz	2.0 dB	Anechoic chamber with tapered dipole antenna NIST standards
Electromagnetic Power Density – Hazard Probes & Meters (0.1 to 1.0) mW/cm ²	0.1 MHz to 45 GHz	2.0 dB	Anechoic chamber with tapered dipole antenna NIST standards
Attenuation – Measure, Incremental Attenuation, (Variable and Step Attenuation)			Using NIST system
(0 to 10) dB (10 to 120) dB	30 MHz 30 MHz	0.003 dB (0.0003*A) dB	A represents the attenuation.

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Reflection – Measure S ₁₁ and S ₂₂ , Magnitude and Phase			Network analyzer reflectometer, Agilent E8364B
Coaxial Type N (0 to 0.10) lin	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18.0) GHz	0.0044 lin; 180° 0.0053 lin; 180° 0.010 lin; 180°	Verification kit: Agilent 85055A
(0.1 to 0.3) lin	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.0062 lin; 2.6° 0.0067 lin; 3.1° 0.014 lin; 5.9°	
(0.3 to 0.7) lin	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.011 lin; 1.2° 0.011 lin; 1.3° 0.027 lin; 2.8°	
(0.7 to 1.0) lin	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.017 lin; 1.0° 0.015 lin; 0.9° 0.040 lin; 2.6°	
Coaxial 7 mm (0 to 0.10) lin	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.0023 lin; 180° 0.0033 lin; 180° 0.0048 lin; 180°	Verification kit: Agilent 85051A
(0.1 to 0.3) lin	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.0034 lin; 1.4° 0.0044 lin; 1.9° 0.0080 lin; 2.6°	
(0.3 to 0.7) lin	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.0054 lin; 1.7° 0.0071 lin; 1.9° 0.015 lin; 3.2°	
(0.7 to 1.0) lin	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.0073 lin; 0.5° 0.0099 lin; 0.6° 0.022 lin; 1.3°	
Coaxial 3.5 mm (0 to 0.10) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 26.5) GHz	0.0049 lin; 180° 0.0080 lin; 180° 0.0089 lin; 180°	Verification Kit: Agilent 85053B
(0.1 to 0.3) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 26.5) GHz	0.0064 lin; 2.8° 0.012 lin; 4.6° 0.013 lin; 5.0°	

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Reflection – Measure S ₁₁ and S ₂₂ , Magnitude and Phase (cont)			Network analyzer reflectometer, Agilent E8364B
Coaxial 3.5 mm (0.3 to 0.7) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 26.5) GHz	0.012 lin; 1.2° 0.025 lin; 2.2° 0.027 lin; 2.5°	Verification kit: Agilent 85053B
(0.7 to 1.0) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 26.5) GHz	0.017 lin; 1.0° 0.040 lin; 2.3° 0.042 lin; 2.4°	
Coaxial 2.92 mm (0 to 0.10) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz	0.0093 lin; 180° 0.0095 lin; 180° 0.015 lin; 180°	Verification kit: Wiltron 3668
(0.1 to 0.3) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz	0.011 lin; 5.2° 0.012 lin; 5.4° 0.019 lin; 7.6°	
(0.3 to 0.7) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz	0.017 lin; 2.1° 0.018 lin; 2.2° 0.031 lin; 3.5°	
(0.7 to 1.0) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz	0.023 lin; 1.4° 0.024 lin; 1.5° 0.042 lin; 2.6°	
Coaxial 2.4 mm (0 to 0.10) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.0090 lin; 180° 0.0094 lin; 180° 0.016 lin; 180° 0.019 lin; 180°	Verification kit: Agilent 85057A
(0.1 to 0.3) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.010 lin; 5.1° 0.012 lin; 5.4° 0.020 lin; 8.9° 0.025 lin; 11.0°	
(0.3 to 0.7) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.015 lin; 2.0° 0.019 lin; 2.2° 0.032 lin; 3.8° 0.039 lin; 4.7°	

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Reflection – Measure S ₁₁ and S ₂₂ , Magnitude and Phase (cont)			Network analyzer reflectometer, Agilent E8364B
Coaxial 2.4 mm (0.7 to 1.0) lin	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.020 lin; 1.2° 0.026 lin; 1.5° 0.043 lin; 2.6° 0.054 lin; 3.3°	Verification kit: Agilent 85057A
Attenuation – Measure, S ₂₁ and S ₁₂ , Magnitude and Phase			Network analyzer with attenuators
Coaxial Type N (0 to 20) dB	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.062 lin; 0.4° 0.067 lin; 0.4° 0.15 lin; 1.0°	Weinschel 919-X attenuators
(20 to 40) dB	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.083 lin; 0.6° 0.13 lin; 0.9° 0.17 lin; 1.1°	
(40 to 50) dB	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.098 lin; 0.7° 0.22 lin; 1.4° 0.20 lin; 1.3°	
(50 to 60) dB	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.12 lin; 0.8° 0.47 lin; 3.2° 0.23 lin; 1.5°	
Coaxial 7 mm (0 to 20) dB	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.049 lin; 0.4° 0.062 lin; 0.4° 0.087 lin; 0.6°	Attenuators within Agilent verification kits 85051A and B
(20 to 40) dB	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.070 lin; 0.5° 0.17 lin; 1.1° 0.11 lin; 0.7°	
(40 to 50) dB	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.086 lin; 0.6° 0.41 lin; 2.8° 0.14 lin; 0.9°	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Attenuation – Measure, S ₂₁ and S ₁₂ , Magnitude and Phase (cont)			Network analyzer with attenuators
Coaxial 7 mm (50 to 60) dB	(0.1 to 45) MHz (0.045 to 2.0) GHz (2.0 to 18) GHz	0.10 lin; 0.7° 1.2 lin; 8.3° 0.17 lin; 1.1°	Attenuators within Agilent verification kits 85051A and B
Coaxial 3.5 mm (0 to 20) dB	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 26.5) GHz	0.069 lin; 0.5° 0.13 lin; 0.8° 0.19 lin; 1.3°	Attenuators within Agilent 85053B verification kits
(20 to 40) dB	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 26.5) GHz	0.17 lin; 1.2° 0.15 lin; 1.0° 0.22 lin; 1.5°	
(40 to 50) dB	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 26.5) GHz	0.42 lin; 2.8° 0.18 lin; 1.2° 0.25 lin; 1.6°	
Coaxial 2.92 mm (0 to 20) dB	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz	0.067 lin; 0.4° 0.10 lin; 0.7° 0.20 lin; 1.4°	Wiltron Attenuators 44KC-X
(20 to 40) dB	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz	0.13 lin; 0.9° 0.13 lin; 0.9° 0.23 lin; 1.5°	
(40 to 50) dB	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz	0.25 lin; 1.4° 0.22 lin; 1.0° 0.32 lin; 1.7°	
Coaxial 2.4 mm (0 to 20) dB	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.07 lin; 0.5° 0.10 lin; 0.7° 0.22 lin; 1.5° 0.32 lin; 2.2°	Attenuators within Agilent 85057A anB verification kits
(20 to 40) dB	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.18 lin; 1.2° 0.13 lin; 0.8° 0.25 lin; 1.6° 0.34 lin; 2.3°	

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Attenuation – Measure, S_{21} and S_{12} , Magnitude and Phase (cont)			Network analyzer with attenuators
Coaxial 2.4 mm (40 to 50) dB	(0.045 to 2.0) GHz (2.0 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.42 lin; 2.8° 0.15 lin; 1.0° 0.27 lin; 1.8° 0.37 lin; 2.5°	Attenuators within Agilent 85057A and B verification kits

IV. Dimensional

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Gage Blocks	(0.01 to 1) in (2 to 20) in	4 μ in (3.3 + 1.5L) μ in	Mechanical comparison; L is the length of the unit under test in inches.
Thread and Gear Wires	(4 to 80) pitch	28 μ in	Mechanical comparison
Precision Balls	To 1 in	27 μ in	Mechanical comparison
Angle Blocks	1' to 45°	1 arc second	Autocollimator/ comparison to master angle block

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Flatness	Up to 10 in diameter	3.2 μ in	Interferometer/master optical flat

V. Mechanical

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Mass	< 100 mg >100 mg to 3 g (> 3 to 10) g (> 10 to 30) g (> 30 to 50) g (> 50 to 100) g (> 100 to 500) g > 500 g to 1 kg (> 1 to 2) kg (> 2 to 5) kg (> 5 to 10) kg (> 10 to 20) kg <0.003 lb (>0.003 to 0.02) lb (>0.02 to 0.2) lb (>0.2 to 0.5) lb (>0.5 to 2) lb (2 to 5) lb (5 to 10) lb (10 to 20) lb (20 to 30) lb (30 to 50) lb (50 to 100) lb < 1/8 oz (> 1/8 to $\frac{1}{2}$) oz (1/2 to 2) oz (2 to 8) oz (8 to 10) oz <50 g (>50 to 200) g (>200 to 1000) g (>1000 to 5000) g (>5000 to 10 000) g	0.32 μ g 0.96 μ g 3.9 μ g 7.8 μ g 13 μ g 22 μ g 83 μ g 160 μ g 510 μ g 1.1 mg 2.5 mg 19 mg 91 μ g 40 μ g 52 μ g 120 μ g 260 μ g 810 μ g 4.3 mg 18 mg 24 mg 45 mg 78 mg 5.6 μ g 1.8 μ g 71 μ g 120 μ g 150 μ g 4.7 μ g 11 μ g 34 μ g 260 μ g 360 μ g	APSL calibration technique # ASL-008

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Force – Load Cells, Proving Rings, etc.	(10 to 1000) lbf	0.01 % of full scale	Deadweight force machine
	(1000 to 1 000 000) lbf	0.05 % of full scale	Morehouse force machine
Torque Cells	To 3000 ft·lb	0.1 % of full scale	Torque calibration
	To 20 000 ft·lb	0.3 % of full scale	Lebow deadweight floating system
Accelerometry	4 Hz to 2 kHz (2 to 100) g	1.5 %	Comparison calibration
	(3 to 10) kHz (2 to 100) g	2.5 %	g is the standard acceleration due to gravity. ($g = 9.8 \text{ m/s}^2$)
Rate Calibration	$\pm 500 \text{ }^\circ/\text{s}$	1.6 %	Frequency counter and DMM
Pressure – Mercurial Manometer, Piston Gages, Piston Gages (medium)	(0.25 to 25) psi (25 to 1000) psi (1000 to 10 000) psi (10 000 to 20 000) psi	24 parts in 10^6 25 parts in 10^6 35 parts in 10^6 17 parts in 10^6	Deadweight piston gage
Vacuum	0.1 torr	0.000024 torr + 1.6 % of reading	MKS PVS-6
	0 torr	0.000032 torr + 2 % of reading	
	10 torr	0.00032 torr + 1 % of reading	
	1000 torr	0.032 torr + 0.57 % of reading	

VI. Acoustical Quantities

Parameter	Range	Best Uncertainty ² (\pm)	Comments
Microphone Sensors	20 Hz to 1 kHz (2 to 7) kHz (8 to 12.5) kHz 250 Hz 2 Hz to 200 kHz 100 Hz to 20 kHz	0.1 dB 0.15 dB 0.3 dB 1 dB 0.08 dB 0.8 dB	Type L pressure reciprocity Voltage insertion Electrostatic actuator Plane wave tube
Sound Calibrators	125 Hz to 4 kHz 20 Hz to 25 kHz	0.3 dB 0.9 dB	Comparison to APSL calibrated standard sound calibrator Voltage insertion

VII. Fluid Quantities

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Gas Mask Tester Calibration	(1000 to 10 000) particles per cc	20 % fit factor	Aerosol measurement and comparison to CNC
Calibration of Air and Gas Flow Meters	(1 to 30) cfm 10 CCPM to 50 L/min	1 % 0.55 % of reading	Bell Prover (air) MoBloc calibration system

VIII. Optical Quantities

Parameter	Range	Best Uncertainty ² (\pm)	Comments
Fiber Optics Power – 10 nW to 100 μ W	850 nm 1310 nm 1550 nm	1.6 % 2.0 % 2.0 %	Detector based

Parameter	Range	Best Uncertainty ² (\pm)	Comments
Fiber Optics Wavelength	(600 to 1700) nm	0.5 nm	Spectrum analyzer and intrinsic source
Spectral radiance – (300 to 1600) nm	(1×10^{-9} to 1×10^{-5}) $\text{Wcm}^{-2}\text{sr}^{-1}\text{nm}^{-1}$	5 %	Detector and source based
Spectral Transmission – (300 to 1500) nm	0 % to 100 %	3 %	Spectrophotometer
Photometric –			
Illuminance	(10 to 500) fcd	2 %	Detector and source based
Luminance	(10 to 10 000) fL	2 %	
Color Temperature	(2000 to 3200) K	17 K	
Laser Energy (1064 nm)	200 nJ to 20 mJ	7 %	Detector based and using beam splitters
Laser Power –			
488 nm	100 mW to 1 W	5 %	Detector based and using beam splitters
514.5 nm	100 mW to 1 W	5 %	
632.8 nm	1 μ W to 30 mW	5 %	
1064 nm	100 mW to 8 W	5 %	
UV Irradiance (365 nm)	(600 to 2000) W/cm^2	10 %	Detector based

IX. Thermodynamics

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Humidity	10 % to 90 %	0.5 %	Two-pressure chamber

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Standard Platinum Resistance Thermometers – Fixed Point Calibrations:	-189 °C to 962 °C		
Triple Point of Water Triple Point of Ar: Triple Point of Hg: Melting Point of Ga Freeze Point of Sn Freeze Point of Zn	0.01 °C -189.3442 °C 38.8344 °C 29.7646 °C 231.928 °C 419.527 °C	0.0010 °C 0.0025 °C 0.0017 °C 0.0018 °C 0.0026 °C 0.0038 °C	Triple points and freezing points using AC bridge
Non-fixed Point Calibration of Temperature Devices Using SPRT	-60 °C to 350 °C	0.008 °C	Direct comparison in baths
Thermocouples – Type S Type K Type J Type T Other Types	0 °C to 1000 °C 0 °C to 1000 °C 0 °C to 750 °C 0 °C to 350 °C 0 °C to 1000 °C	0.75 °C 3 °C 3 °C 1.5 °C 5 °C	Direct comparison
Blackbody Radiation Temperature	10 °C to 1000 °C	2.2 °C	Direct comparison

¹ This laboratory offers commercial calibration service.

² “Best Uncertainty” is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards of nearly ideal measuring equipment. Best uncertainties represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The best uncertainty of a specific calibration performed by the laboratory may be greater than the best uncertainty due to the behavior of the customer’s device and to influences from the circumstances of the specific calibration.